Measuring, Registering and Recording the vectors' characteristics of Induction Machines

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Abstract*—Evolution of power semiconductor devices and power static frequency converters is a key factor in development of advanced applications. Availability of energy sources derived adjustable frequency AC motor allowed to reach a new horizon in research studies and technical applications, completely untapped today.However, the advantages inherent in the operation of adjusting the frequency cannot be fully exploited without adopting a proper control strategy, which is essential in characterizing the parameters and the overall performance of a command system. Control techniques are to ensure a fair and effective command of the operation. During normal operation, the nominal engine and inverter must be secured and the engine order should be placed in area of maximum torque. In case of overloads or faults of another nature, redesigning of installation parts is preferable in order to adopt advanced operating strategies and to determine the parameters.*

Keywords*— *Scalar control, vector control, estimate parameters, sensors monitoring, coordinate system (α, β), coordinate system (d,q).

I. INTRODUCTION

Issues of control parameters in an electric drive should be considered in a different manner like control systems design engineering. It is suitable to consider a set of black boxes connected in cascade. Each module has a well-defined mathematical model with linear variation. Applications to a command in the AC system are now very complex which can simultaneously control many parameters with linear variation and hardly can be described analytically using a model. Even if it takes a vector control strategy to obtain a similar behavior to that of a DC motor, several problems still remain unresolved due to the particular engine and converter structures and their interaction with load and source.

Torque pulsations, the frequency harmonic content, optimize efficiency, change parameters, response time, are only few of many issues to be resolved. The control strategies presented in this paper will be helpful to solve these challenges.

Another major factor that assisted shareholders AC technology in control issues is the development of microprocessors. Complex microprocessors, and DSP (Digital Signal Processor) have the ability to directly calculate the ignition time of a power semiconductor circuit of a three-phase bridge, by adjusting the power frequency. Besides, it performs other important tasks in industrial automation application as well as startup and shutdown sequencing, self-testing, monitoring deficiencies, diagnosis and determining system operating parameters or dynamic stationary. However, the most important contribution of microprocessor power is that it opens new frontiers for implementing sophisticated control systems for electric drives. These modern techniques of control permit the control of adaptive and intelligent control logic for the expert systems and neural networks diffuse. These achievements are applied to variable frequency drives without major complications for the operation and structure which helps to simplify the above issues, particularly in certain categories of applications such as robotics.

Variable frequency drives can lead to an increase in the efficiency by 20 to 30% compared to constant speed systems. This means a major economic power in a short period, taking into account the additional costs of equipment and force. Such energy savings were so convincing that variable speed drives for pumps and fans are today available in the market for electric drives.

In industrial automation, the need for safe and easy integration of the element of performance (drive) automatic process, found an adequate response in the performance of variable frequency drives. As a result, the automated hydraulic and pneumatic systems are being replaced today by electric drives to ensure speed , higher precision control, a better power / weight, ruggedness and the free and easy maintenance.

The two classes of electric drives have very different control schemes. Variable speed drives presents a constant ratio of voltage / frequency in open loop for shareholders without pretensions to improve energy control. On the other hand, high dynamic performance drives are made with a control complex, usually involving vector control for regulation independent torque and flux, including how to reduce the field of high speed operation.

Simple and cheap method of induction motor speed control by keeping the voltage / frequency ratio constant has been

studied and applied extensively. The method is derived from the point that at constant flow, the ratio of field amplitude and frequency remain constant, only if the slip is kept constant. Operation at constant torque variable speed is made until it reaches a speed corresponding to the nominal voltage of the machine.

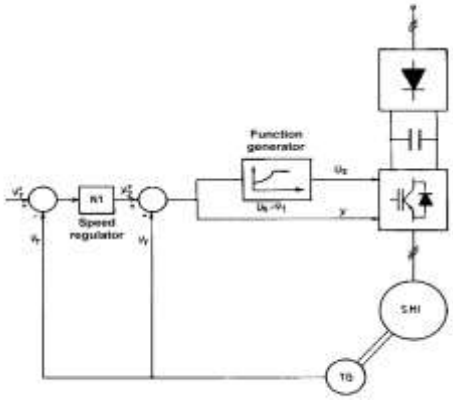

Fig.1: Scalar control in closed loop by speed and slipping adjusting.

In time many improvements have been introduced in the control scheme to overcome some of the most important disadvantages.

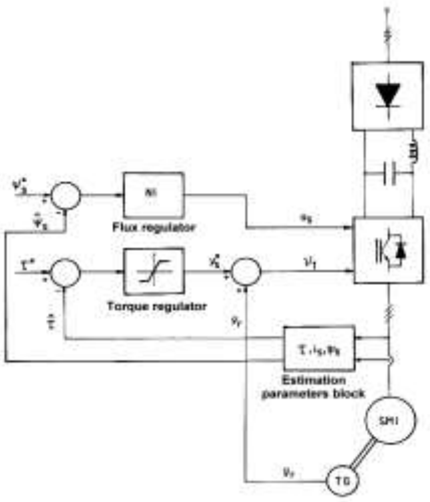

Fig.2: Adjustable flux and torque scalar control with integrated block of operating parameters estimation.

For example, offsetting the fall of voltage on the stator windings can be achieved by implementing a characteristic voltage / frequency. the voltage is amplified and over the face value proportional to frequency. Voltage amplification can be made proportional to the stator current value or (alternatively) to the component of stator current phase. Closed-loop control current during operation was introduced to address the emergence over-current trigger while adjusting the slip frequency is usually added to compensate the speed fall due to load functioning. Although the performance of a drive is improved by the methods suggested, the ratio voltage / frequency remains constant. The process of an inner control of the design is still difficult because it cannot maintain the flux of air-gap same as the desired value, corresponding to operating point value. Changing parameters due to temperature and saturation disrupt response to other operating points. Scalar control was introduced to allow for the installation and to provide performance when needed better dynamic performance .

Such scheme is based on separate control of flux and torque, but both voltages and currents must be measured to calculate the instantaneous measurements of flux and arbor torque.

II. MATHEMATICAL EQUATIONS OF A.C. MACHINES IN DIFFERENT COORDINATE SYSTEMS

Logical extension of the system matrix and the generalized theory of electrical machines can read equations and power flux, the corresponding parameters of the machine, the expressions of electrical power and electromagnetic torque. Stator voltage equation is formulated in a standstill. Voltage space vector can be defined similar to a current space vector [1], [2]:

$$u_s = \frac{2}{3}\left(u_A + au_B + a^2u_C\right) \tag{1}$$

Voltage equation of phase B is multiplied by „a”, the phase C is multiplied by „a^2” and all three equations are multiplied by 2/3:

$$\left.\begin{aligned} u_A &= i_A R_s + \frac{d\Psi_A}{dt} \\ u_B &= \left(i_B R_s + \frac{d\Psi_B}{dt}\right) \Big| \cdot a \\ u_C &= \left(i_C R_s + \frac{d\Psi_C}{dt}\right) \Big| \cdot a^2 \end{aligned}\right| \cdot \frac{2}{3} \tag{2}$$

Bringing together the three equations is obtained:

$$\begin{aligned} &\frac{2}{3}\left(u_A + au_B + a^2u_C\right) = \\ &= \frac{2}{3}\left(i_A + ai_B + a^2 i_C\right)R_s + \\ &+ \frac{d}{dt}\left[\frac{2}{3}\left(\Psi_A + a\Psi_B + a^2\Psi_C\right)\right] \end{aligned} \tag{3}$$

Analogically, equation 1 defining voltages vector, similarly, the Ψ_S vector can be written as:

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$$\Psi_s = \frac{2}{3}\left(\Psi_A + a\Psi_B + a^2\Psi_C\right) \tag{4}$$

So, the space vector of stator voltage is:

$$u_s = i_s R_s + \frac{d\Psi_s}{dt} \tag{5}$$

Analogically, for the rotor is obtained:

$$u_r = i_r R_r + \frac{d\Psi_r}{dt} \tag{6}$$

u_r, i_r şi ψ_r have the same expressions as those of spatial vectors of the stator, the indices A, B, C being replaced by a, b, c.

The same equation can be expressed with Park vectors and can be obtained by designing the two phases α, β. For stator and rotor voltage equations are [1], [2]:

$$u_\alpha = i_\alpha R + \frac{d\Psi_\alpha}{dt},\ u_\beta = i_\beta R + \frac{d\Psi_\beta}{dt} \tag{7}$$

Combining these two equations it obtained:

$$u_\alpha + ju_\beta = \left(i_\alpha + ji_\beta\right)R + \frac{d}{dt}\left(\Psi_\alpha + j\Psi_\beta\right) \tag{8}$$

Which given the transformation expressions from simplified complex equations into instantly, get global equivalent equation:

$$u = iR + \frac{d\Psi}{dt} \tag{9}$$

Similar to the derivation of voltage spatial vector equations and vector spatial flux equations can be derived from the three phases A, B, C or rectangular phases α, β. The most convenient is to use reference system with α, β, therefore, instead of depending on inductance matrices we will consider the following:

$$\begin{array}{c|c} & \begin{array}{ccc} A & B & C \end{array} \\ \begin{array}{c} A \\ B \\ C \end{array} & \begin{bmatrix} l_{ss} & l_{ms} & l_{ms} \\ l_{ms} & l_{ss} & l_{ms} \\ l_{ms} & l_{ms} & l_{ss} \end{bmatrix} \end{array} \tag{10}$$

and

$$\begin{array}{c|c} & \begin{array}{ccc} a & b & c \end{array} \\ \begin{array}{c} A \\ B \\ C \end{array} & \begin{bmatrix} \cos\alpha & \cos(\alpha + 120°) & \cos(\alpha + 240°) \\ \cos(\alpha + 240°) & \cos\alpha & \cos(\alpha + 120°) \\ \cos(\alpha + 120°) & \cos(\alpha + 240°) & \cos\alpha \end{bmatrix} \end{array} \tag{10}$$

where:

l_{ss} is own stator inductance;

l_{ms} is the mutual inductance of stator;

α is the angle between the stator and rotor corresponding phases.

The inductances matrix is:

$$\begin{array}{c|c} & \begin{array}{ccc} 0 & \alpha & \beta \end{array} \\ \begin{array}{c} 0 \\ \alpha \\ \beta \end{array} & \begin{bmatrix} l_{ss} + 2l_{ms} & & \\ & l_{ss} - l_{ms} & \\ & & l_{ss} - l_{ms} \end{bmatrix} \end{array} \tag{11}$$

The corresponding inductances of α and β phases are equals and the spatial current vector is: $i = i_\alpha + ji_\beta$. So, for an arbitrary space distribution, the stator inductance is:

$$L_s = l_{ss} - l_{ms} \tag{12}$$

For sinusoidal spatial distribution:

$$l_{ms} = l_{AB} = L_{ms}\cos 120^0 = -\frac{L_{ms}}{2}$$
$$l_{ms} = l_{AC} = L_{ms}\cos 240^0 = -\frac{L_{ms}}{2} \tag{13}$$

l_{ss} inductance is bigger than mutual inductance L_{ms}:

$$l_{ss} - l_{ms} = \left(L_{sI} + L_{ms}\right) - \left(-\frac{L_{ms}}{2}\right) = L_{sI} + \frac{3}{2}L_{ms} \tag{14}$$

Hence, the stator three-phase inductance:

$$L_s = L_{sI} + \frac{3}{2}L_{ms} \tag{15}$$

By considering equations 10, 12 and 13, in case spatial sinusoidal distribution:

$$l_{ss} + 2l_{ms} = L_{sI} + L_{ms} - 2\frac{L_{ms}}{2} = L_{sI} \tag{16}$$

So:

$$L_{s0} = L_{sI} \tag{17}$$

However, this result above needs correction, while the inductance is determined even of space harmonics multiplied by 3 phases and the number of poles. Similarly, the total three-phase rotor own inductance is [5]:

$$L_r = L_{rI} + \frac{3}{2}L_{mr} \tag{18}$$

$$L_{r0} = L_{rI} \tag{19}$$

Considering expression stator-rotor mutual inductance matrix, and making necessary changes to the components α, β, the equation of flux is:

$$\begin{bmatrix}\Psi_0\\ \Psi_A\\ \Psi_B\end{bmatrix}=\frac{3}{2}L_{sr}\begin{array}{c|ccc|}
 & i_0 & i_\alpha & i_\beta\\
 & 0 & \alpha & \beta\\
0 & 0 & 0 & 0\\
A & 0 & \cos\alpha & -\sin\alpha\\
B & 0 & \sin\alpha & \cos\alpha
\end{array}\begin{bmatrix}i_0\\ i_\alpha\\ i_\beta\end{bmatrix} \quad (20)$$

Stator mutual flux losses caused by rotor current:

$$\begin{aligned}
\Psi_{sm} &= \Psi_{Am}+j\Psi_{Bm}=\\
&=\frac{3}{2}L_{sr}\left[\left(\cos\alpha\cdot i_\alpha-\sin\alpha\cdot i_\beta\right)+j\left(\sin\alpha\cdot i_\alpha+\cos\alpha\cdot i_\beta\right)\right]=\\
&=\frac{3}{2}L_{sr}\left[i_\alpha\left(\cos\alpha\cdot+j\sin\alpha\right)+ji_\beta\left(\cos\alpha\cdot+j\sin\alpha\right)\right]=\\
&=\frac{3}{2}L_{sr}\left(i_\alpha+ji_\beta\right)e^{j\alpha}=\frac{3}{2}L_{sr}e^{j\alpha}i_r
\end{aligned} \quad (21)$$

Hence, stator-rotor mutual inductance is:

$$L_m=\frac{3}{2}L_{sr} \quad (22)$$

and it must be multiplied by the $e^{j\alpha}$ factor due to the relative rotation of two reference systems. Stator-rotor mutual inductance matrix is transposed stator-rotor mutual inductance matrix. The same expression is obtained for the mutual inductance L_m if deemed transposed matrix and instead $e^{j\alpha}$, we obtain $e_{-j\alpha}$ multiplier.

Hence the vector equations of flux in the natural reference system are:

$$\begin{aligned}\Psi_s&=L_si_s+L_me^{j\alpha}i_r\\ \Psi_r&=L_me^{-j\alpha}i_s+L_ri_r\end{aligned} \quad (23)$$

where L_s, L_r, L_m are definite in (15), (18), (22).

The equations become:

$$\begin{aligned}\Psi_{s0}&=L_{s0}i_{s0}\\ \Psi_{r0}&=L_{r0}i_{r0}\end{aligned} \quad (24)$$

III. ELECTRIC POWER AND ELECTROMAGNETIC TORQUE

For symmetrical three-phase systems, instantaneous power can be expressed according to the reference system (α, β) as follows [2], [3]:

$$p=\frac{3}{2}\left(u_\alpha i_\alpha+u_\beta i_\beta\right)+3u_0i_0 \quad (25)$$

If, for three-phase vectors, to complex power (ui*) it is applied the simplified complex transformation method, we obtain:

$$\begin{aligned}ui^*&=\left(u_\alpha+ju_\beta\right)\cdot\left(i_\alpha-ji_\beta\right)=\\ &=u_\alpha i_\alpha+u_\beta i_\beta+j\left(u_\beta i\alpha-u_\alpha i_\beta\right)\end{aligned} \quad (26)$$

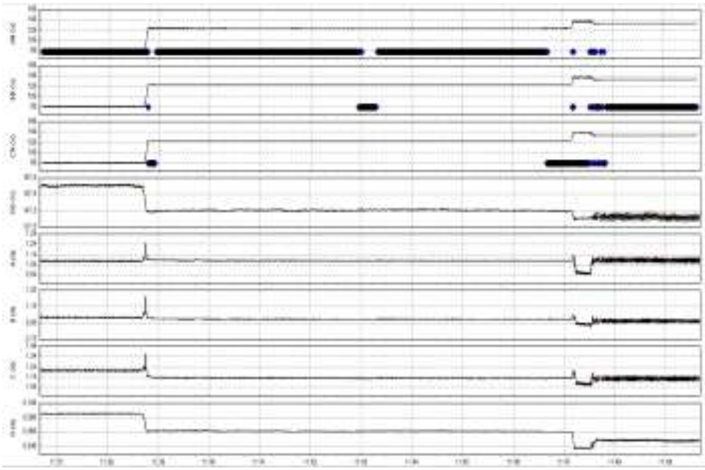
Hence, the instantaneous power is obtained as 3/2 times the real part of this expression - if components are not zero:

$$p=\frac{3}{2}\mathrm{Re}[ui^*] \quad (27)$$

occasionally, power sequence 0: $p_0=3u_0i_0$ (28)

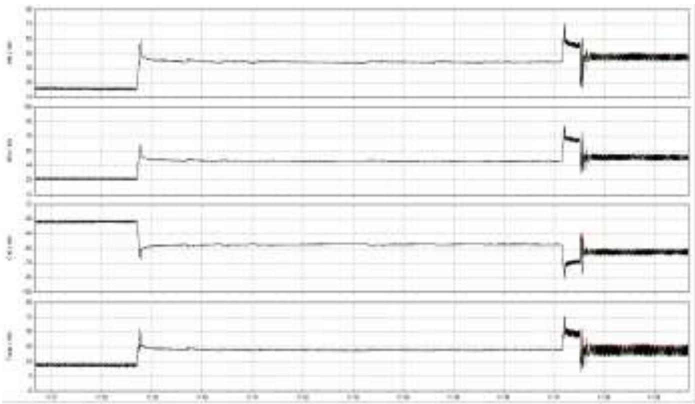
If we add to the instant power of the stator and rotor and if they are calculated separately by applying equation (27):

$$p=p_s+p_r=\frac{3}{2}\mathrm{Re}\left[u_si_s^*+u_ri_r^*\right] \quad (29)$$

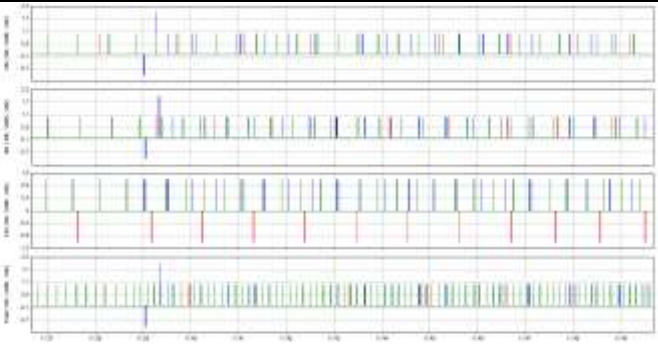


a. The voltage and current

b. Frequency



c. Power



d. Energy

Fig.3: Determination of main parameters of A.C. induction machine

If equation defining voltage and current space vectors are replaced in equation (29) is obtained:

$$\frac{3}{2}\mathrm{Re}\left[\frac{2}{3}\left(u_a + au_b + a^2u_c\right)\cdot\frac{2}{3}\left(i_a + ai_b + a^2 i_c\right)\right] = \\ = u_a i_a + u_b i_b + u_c i_c \qquad (30)$$

The value obtained is equal to an instantaneous value of power. In Fig. 3 are highlighted possibilities for determining and measuring main parameters of A.C. induction machine for a low power three-phase A.C. machine.

To obtain the appropriate electromagnetic torque relationship can use in a similar fashion to those described above, coordinate system (α, β), but the most convenient way to get this relationship is using common reference for the stator and rotor (System Reference (d, q)).

Expression in the reference torque (d, q) for a synchronous machine is:

$$\tau = -i_D L_{dD} i_q + i_Q L_{qQ} i_d - i_d i_q \left(L_d - L_q\right) \qquad (31)$$

Rotor flux and space current vectors can be expressed in the reference system (d, q) as follows:

$$\Psi_r = \Psi_d + j\Psi_q = L_d i_d + L_{dD} i_D + j\left(L_q i_q + L_{qQ} i_Q\right) \\ i_r = i_d + ji_q \qquad (32)$$

If the complex conjugate vector space of flux rotor is multiplied by the current space vector of rotor get:

$$\Psi_r^* i_r = L_d i_d^2 + L_{dD} i_D i_d + L_q i_q^2 + L_{qQ} i_Q i_q + \\ + j\left(-L_q i_q i_d - L_{qQ} i_Q i_d + L_d i_d i_q + L_{dD} i_D i_q\right) \qquad (33)$$

and: $\tau = -\frac{3}{2}\mathrm{Im}\left[\Psi_r^* i_r\right]$ (34)

Apply the multiplier 3/2 and introduce the term derivative of torque, the expression becomes equivalent to equations with two-pole machine, and for a multi-pole machine, mathematical expression should be multiplied by the number of poles P.

Equation 34 can be written in the following form by considering the angle β between the 2 vectors:

$$\tau = -\frac{3}{2}\left|\Psi_r\right|\left|i_r\right|\sin\beta \qquad (35)$$

By considering the interpretation of a product of vectors, torque is described by a vector that is perpendicular to the plane defined by ψ_r and i_r with a value equal to 3/2 times the area of the parallelogram in Fig. 2, as follows:

$$\tau = -\frac{3}{2}\Psi_r \times i_r = \frac{3}{2}\Psi_s \times i_s \qquad (36)$$

Torque expression obtained has not only spatial distribution but also a sinusoidal temporal variation arbitrary. In a multi-pole machine, it must be multiplied by the number of pole pair's "p" [3], [4].

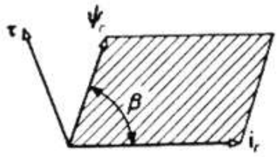


Fig.4: Torque vector result of flux and current vectors

IV. DISPLAYING AND RECORDING THE THREE PHASE VECTORS

The phase vectors can be displayed on an oscilloscope screen or within a LabVIEW application. Since the deflection plates act in orthogonal directions, voltages expressed in a rectangular system have to be considered. For the current vectors, appropriate voltages may be obtained by using shunt resistances, Fig. 5,a and b.

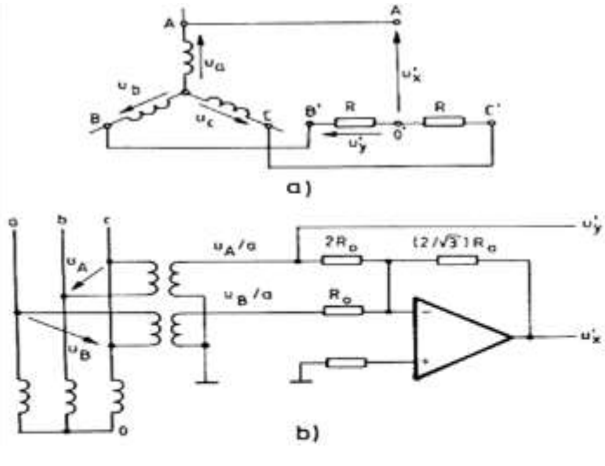


Fig.5 Determination of voltages at the terminals of a three-phase consumer
a)Vector diagram. b) Practical realization

The results displayed on the oscilloscope can be photographed using special devices which make it possible to assess the size and elaborate the results [8].

4.1. Display the voltage vectors

Display of voltage vectors is quite simple using the circuit of Fig. 3.a, where A, B and C are the terminals of the three

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phases, and 0 is the neutral point of the star on which the electric machine is tested. The neutral point is not actually necessary in this situation, so that the same configuration can be used for the connection triangle. The common point of two resistors 0 must to be connected to the common mass of amplifiers and oscilloscope, while the voltages u_x' and u_y' are applied to the inputs of the horizontal and vertical amplifiers [10].

The

$$u_y' = \frac{1}{2}(u_b - u_c)$$
$$u_x' = u_y' - u_b + u_a = -\frac{1}{2}(u_b + u_c) + u_a \qquad (37)$$

Comparing these expressions with the real and imaginary parts of the voltage vector:

$$\mathrm{Re}[u] = \frac{2}{3}u_a - \frac{1}{3}(u_b + u_c) + u_x$$
$$\mathrm{Im}[u]\frac{1}{\sqrt{3}}(u_b - u_c) = u_y \qquad (38)$$

one obtains:

$$u_x' = \frac{3}{2}u_x; \quad u_y' = \frac{\sqrt{3}}{2}u_y \qquad (39)$$

The input voltage is indeed proportional to the volt vector coordinates considering a $\sqrt{3}$ scale factor.

This can be taken into account by setting the gain of amplifiers (Fig. 3b). The above equations are valid also for the phase voltages of star connections with zero sequence components, but in this case the projection vector on axis is not apparent in phase quantities. Care should be taken not to apply excessive loads on voltage ux', because in this case the load will also contain u'y component. If the load cannot be reduced, the circuit configuration must be modified to eliminate unwanted interactions. The load is connected to terminals O'B (at u'y) and another identical load will restore the balance circuit terminals O'C.

In practice, an indirect measurement scheme is normally used, in which the voltage transformer is connected to the line terminals of the test machine.

If there is no zero sequence component, $u_a + u_b + u_c = 0$, equation (38) can be written in a simpler form:

$$u_x = u_a - (u_b + u_c)$$
$$u_y = \frac{1}{\sqrt{3}}(u_b - u_c) \qquad (40)$$

The x and y components of the voltage vector u can be obtained from two line voltage using the following equations:

$$\sqrt{3}u_x = -\frac{1}{\sqrt{3}}u_A - \frac{2}{\sqrt{3}}u_B$$
$$\sqrt{3}u_y = u_A \qquad (41)$$

The scheme of Fig. 3b includes two power transformers and an operational amplifier. From this scheme. The signals are proportional to the voltage vector components that can be displayed on the oscilloscope:

$$u_x' = \frac{\sqrt{3}}{a}u_x; \quad u_y' = \frac{\sqrt{3}}{a}u_y$$

(42) These signals must be applied directly to horizontal and vertical oscilloscope inputs.

4.2. Display the current vectors

In order to show the current vectors on the oscilloscope screen, the resulting voltages are proportional to the two components of the current vector and should be applied to the inputs of the oscilloscope deflection plates, Fig 6.

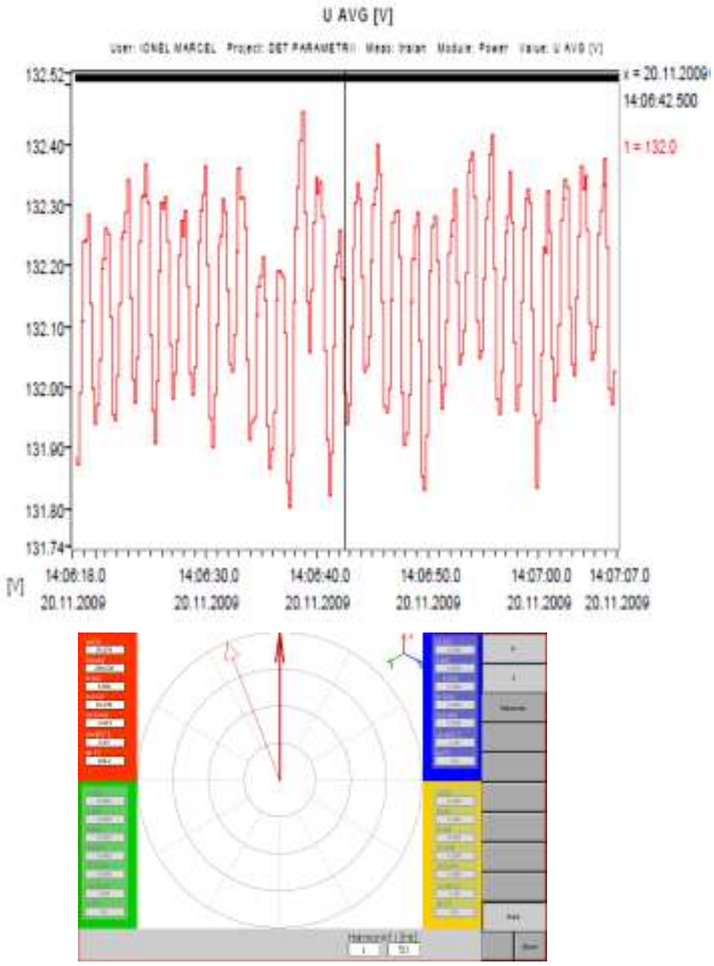


Fig.6. Displaying voltage vectors at the terminals of an induction motor at low frequency.
a) Sinusoidal diagram, b) Vector diagram

Equations (38) or (40) can be used to calculate the vector components. When only three terminals of the machine windings are available, current transformers may be used. When 6 terminals are available, the current transformers can be omitted from the measurements.

Three current transformers are needed if the current system is unbalanced, that is, when there is zero sequence current on the neutral line. In practice, however, $i_0 = 0$ in most cases [19]. When using current transformers, the secondary currents i_b and i_c flow through identical resistors (as in Fig. 7). Care should be taken to the polarization of each winding. As the sum of the three currents is zero, the voltage drop between points C and B is i_s i_{aR}. Hence, the three phase voltage system shown in points A, B and C will be proportional to the current system, so the current vectors can be displayed in the same way as the voltage vectors. Unfortunately, in most cases, the standard current transformers do not produce a sufficiently high voltage in the secondary for a small primary current [11].

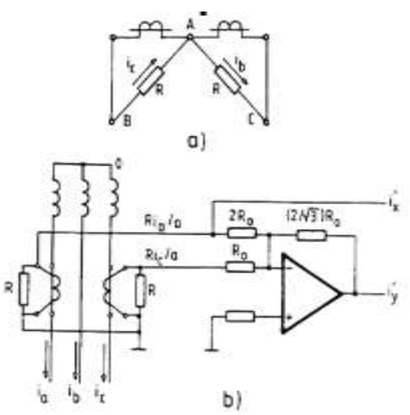


Fig.7: Determination of current at the terminals of a three-phase consumer
a) Vector diagram. b) Practical realization

In practice, the scheme of Fig. 7.b, can be used, with a general operational amplifier to display the current vectors. Since $i_x = i_a$, the only problem is to generate iy. For instance, equation (38) shows that:

$$i_y = -\frac{1}{\sqrt{3}} i_a - \frac{2}{\sqrt{3}} i_c \tag{43}$$

Another way to generate the y component of the current vector i is analytical. This expression can be represented by the circuit configuration shown in Fig. 7b. Taking into account the transformation ratio of the current transformers and the voltage drop on the resistors of value R, the signals are proportional to the components x and y, of the vector current:

$$i_x^{'} = \frac{R}{a} i_x; \quad i_y^{'} = \frac{R}{a} i_y \tag{44}$$

Current transformers can be replaced by other current sensors, Hall elements or optic-couplers. Current transformers cannot be used when accurate measurements of DC components transient phenomena are important for signal recording, or when the frequency is too low. In such cases other devices have to be installed (e.g., shunt resistors), Fig. 8.

V. HARMONIC ANALYSIS OF THREE-PHASE VECTORS

In steady state, the voltage vector u(t), the current i(t) and the flux Φ(t) along a closed curve have a sinusoidal variation in time. In the sequel, how to determine the harmonic components from the curves is presented. This method is analyzed in a particular case, with a stable state of circuit and systems, or when the motor is controlled in steady state.

Let us consider a periodic function of period T, expressed in the form y(t) = y(t+T). By calculating the Fourier series:

$$y(t) = \sum_{v=-\infty}^{\infty} Y_v e^{jv\omega_1 t} \tag{45}$$

where $\omega_1 = 2\pi / T$ and v is the harmonic order.

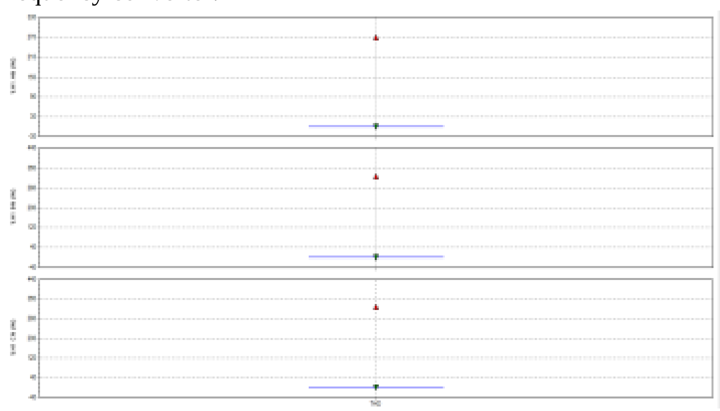
After several complete rotations, a complete value of three-phase simmetrical sinusoid can be represented. The Fourier coefficients can be determined as follows:

$$Y_v = \frac{1}{T}\int_0^T y(t) \cdot e^{-jv\omega_1 t} dt \tag{46}$$

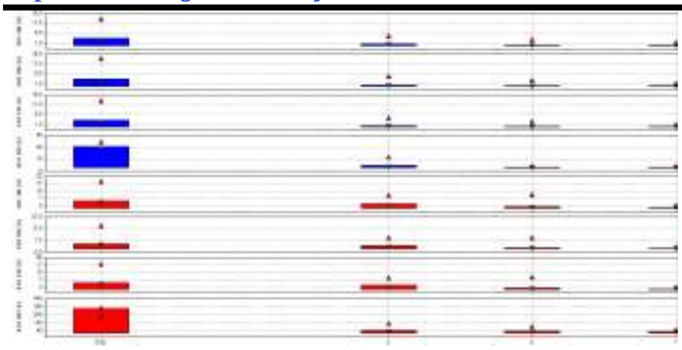
If y(t) is determined by sampling the waveform, the integral is replaced by a sum. For γ = 1, equation (46) represents the fundamental frequency:

$$Y_1 = \frac{1}{T}\int_0^T y(t) \cdot e^{-j\omega_1 t} dt \tag{47}$$

Fig.8 shows the diagrams of frequency parameters for the case of a small power induction motor commanded by a frequency converter.



a. Superior harmonics



b. Power and harmonics

Fig.8. Diagrams of frequency parameters at the terminals of a three-phase consumer balanced in dynamic system

By recalculating the expression of equation (46) transforming the coordinate reference system, one can see that the value of the function to be integrated is not greater than the fundamental component in a fixed coordinate system (synchronous rotation):

$$\omega_1 t = x_c, \omega_1 = \omega_c .$$

From this expression we observe that the fundamental component is higher than the component represented in the synchronous rotation system.

VI. CONCLUDING REMARKS

Today, thanks use semiconductor circuits and electronic devices , electromagnetic techniques were replaced with efficient techniques and high control accuracy. Electromagnetic converters performance was gradually improved , allowing to obtain any desired mechanical characteristics to any type of motor.

The introduction of the electric machines controlled by static converters leads to the need of identifying stationary and dynamic parameters, simultaneously with the identification of dynamic phenomena and waveform distortion introduced by them. However, this does not mean that all types of motors are equal in terms of price, performance control, efficiency, optimal weight, etc. The electromagnetic structure and operating principle can be the other crucial aspects affecting the effectiveness of the energy system [12].

The structure of the machines with static converter control is often built especially to provide electronic control and create specific converters used in mechatronics. Electronic control system performance has improved not only the energy startegies, but has also changed the general philosophy of design and complete development of new types of machinery. For further progress in this area it is necessary to consider simultaneously the electronic circuit supply and the electromagnetic field structure [12], [13], [14].

A conventional electronic control (with pulse modulation - PWM) has some typical disadvantages, such as high bandwidth of the fundamental harmonic voltage, pulses of torque, the influence of asymmetry in the structure especially at low angular speed, the need for additional external cooling at low speed, radio interference and energy provision with relatively low efficiency of the machines.

To determine the design of the control circuits define first , precise movements of the car to try to define specifications and rules with sufficient precision, so the circuit is well known. Until now, electric cars all started with the final configuration methods and evaluation of geometric and after repeated analysis is to find the optimal solution . How to do research to find solutions to real machine parameters highlights the degree to which it defines as optimal solution is highly variable.

Users of software dedicated to the left first attempt to make the determination of optimized parameters of different configurations of electric machines and, on the other hand, processing of the results obtained. Also, by the method of multiple search procedure can be done to define objectives, and later to realize automatic filling of the problem by choosing solutions without user intervention.

Final configuration, starting from the initial state of the machine makes it impossible to determine the broader parameters, typical for early definition of the choice of type of motor (usually the winding coils, cold rolled electromagnetic materials etc.). The procedures for choosing the type of motor and drive are certainly not enter into detailed projections of the motor without prior specifications.

In this study are highlighted the computer methods used for automated search optimization and determination of parameters. The basis for these methods is to define a single objective function that can be determined with minimal effort. In this study , attention was directed to seek new methods for determining operating parameters involving and choosing the right control.

Compared with uniform harmonic content networks DC, AC drives generate harmonics unitary additional harmonic band called marginal (tape edge) . Compared to other AC units currently used , frequency converters generate significant levels of higher order harmonics .

To assess if a converter can disrupt its command or other tasks, a system study must be completed before installing such a converter. The drive is larger and more complex, with both increases and importance of the study to be conducted.

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